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A reflection model for the cyclotron lines in the spectra of X-ray pulsars

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Abstract

Cyclotron resonance scattering features observed in the spectra of some X-ray pulsars show significant changes of the line energy with the pulsar luminosity. At high luminosities, these variations are often associated with the onset and growth of the accretion column, which is believed to be the origin of the observed emission and of the cyclotron lines. However, this scenario inevitably implies a large gradient of the magnetic field strength within the line-forming region, which makes the formation of the observed line-like features problematic. Moreover, the observed variation of the cyclotron line energy is much smaller than could be anticipated for the corresponding luminosity changes. We argue here that a more physically realistic situation is that the cyclotron line forms when the radiation emitted by the accretion column is reflected from the neutron star surface, where the gradient of the magnetic field strength is significantly smaller. Here we develop a reflection model and apply it to explain the observed variations of the cyclotron line energy in a bright X-ray pulsar V 0332+53 over a wide range of luminosities.

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Keywords

line: formation, pulsars: general, relativistic processes, scattering, stars: neutron, X-rays: binaries